Effects of Antecedent Manipulations and Social Reinforcement to Increase Lateral Positioning in a Premature Infant with Obstructive Sleep Apnea

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Abstract Recent research suggests supine positioning for sleeping infants is the safest position to prevent breathing related difficulties; however doing so can significantly increase obstruction in apneic infants resulting in decreased sleep quality. We implemented a multi-component treatment package comprised of antecedent interventions and parent-mediated social reinforcement to increase lateral positioning in a premature infant with obstructive sleep apnea. Results indicate that the intervention increased lateral positioning in the participant by over 80 % in the final phase of the study, indicating efficacy of the intervention. Limitations and suggestions for future research are discussed.

Summary for Clinicians • A single case analysis was completed with a premature infant suffering obstructive sleep apnea using a rigorous, multi-element treatment package.

- Antecedent manipulations such as placement of a stimulus are generally simple to implement, yet effective in increasing socially valid behavioral outcomes while, in this study, also increasing physiologically necessary outcomes.
- Utility of behavioral methods is effective in various populations and can be advantageous beginning in early infancy.
- Parent attention when combined with other manipulations is effective for shaping sleeping posture in infants.

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Since 1994, it has been recommended that infants sleep in a supine position in order to reduce the risk of infant mortality due to sleep-related deaths such as suffocation or strangulation (Hauck, Tanabe, McMurry, & Moon, 2015). However, Menon and Kumar (2013) found a supine sleeping posture is more commonly associated with obstructive sleep apnea (OSA), a common condition in infants, particularly those born prematurely. Katz, Mitchell, and D'Ambrosia (2012) indicate infants have “both anatomical and physiological predispositions toward airway obstruction and gas exchange abnormalities including superiorly placed larynx, increased chest wall compliance, ventilation-perfusion mismatching, and ventilatory control instability.” In addition to prematurity, OSA is increasingly common in infants born with Down syndrome (Goffinski et al., 2015), craniofacial conditions, and various other genetic syndromes (Bacher et al., 2011). Infants with OSA who sleep in supine positions have been found to suffer decreased sleep quality and efficiency such as frequently interrupted sleep due to a significant increase in the number of awakenings and obstructions (Bhat et al., 2006).

Afrashi and Ucar (2015) emphasize sleeping in a prone position is an effective method for managing OSA as it reduces the effect gravity has on collapsibility of the upper airway. However, despite the decrease in sleep-related infant mortality in the recent years, prone sleeping is still not recommended. Infants who suffer from OSA are more likely to experience exacerbation from sleeping in the supine position. In order to reduce the risk of breathing-related complications during sleep and promote sleep

quality, it has been found that infants and children afflicted with OSA may benefit from sleeping in a lateral position as a systematic review revealed fewer obstructive events in this position (Menon & Kumar, 2013).

Infant positioning for awake activities and sleep time is crucial for various developmental factors such as motor development, increased muscle tone, circulation, and respiration (McMullen, 2013). However, requiring an infant to remain in a particular position such as prone for play or supine for other activities evokes a number of challenging behaviors including crying, non-compliance, and attempts to aggress toward the caregiver. Recent studies demonstrate the efficacy of behavioral interventions such as videos and auditory stimuli, as well as the delivery of parent attention (Kadey & Roane, 2012; Ortega & Fienup, 2015) in increasing head elevation and reducing negative vocalizations. Positioning of videos as well as parent attention has been found effective in changing the position of the infant to facilitate learning or implementation of other activities. However, there is limited research evaluating if the aforementioned interventions are effective in increasing sustainability of the prescribed posture for an extended period of time. As such, the purpose of this study was to evaluate the effects of antecedent manipulations and social reinforcement on the duration of time the participant remains in a lateral position while in his crib. We hypothesize that the treatment package will result in an increased duration of lateral positioning as demonstrated by a functional relationship between treatment package and target behavior via an ABAB reversal design. Although this study does not directly evaluate sleep in such position, it is further hypothesized that increasing awake side lying when in the crib (which would likely serve as a motivating operation) and under the stimulus control of antecedent manipulations, this behavior may generalize to sleep in this position; however, this will need to be evaluated separately in future research. As such, the goal of this study is to increase lateral positioning to be paired with the crib.

Methods

Participant

The participant of this study was a 6-month-old male who was born prematurely at 33 weeks gestational age via cesarean section. The participant's mother was pre-eclamptic resultant of pre-existing maternal pathology including high blood pressure and being overweight, based on parental report, indicating the need for cesarean section delivery. Parent reports also indicate that the participant underwent polysomnography at approximately 6 weeks of age which resulted in a diagnosis of moderate OSA. The participant had no other known health-related conditions at the time of the intervention. Due to

increased instances of obstruction in a supine position and increased risk of SIDS in a prone position, a lateral, side-lying sleep position to increase duration of sleep and overall sleep quality was recommended. Parent reports indicate that when placed on his side, within approximately one-minute he would roll on to his back. In addition, their previous attempts at sustaining a side-lying position, which included continuously turning him back to his side, had been unsuccessful.

Data Collection

Whole interval recording was used during the duration of the study, utilizing 30 one-minute intervals for a total observational period of 30 minute during each session. An interval was recorded when he was laying on his side facing the preferred stimuli as evidenced by the side of his torso and side of his face making contact with the bottom of the crib for the entirety of the interval.

Interobserver Agreement

Interobserver data were collected for 25 % of sessions by an independent observer. Independent observer agreement (IOA) was calculated by a percent-of-intervals method (House, House, & Campbell, 1981). Data were required to meet a minimum of 90 % agreement to be considered clinically valid. All IOA data presented met this requirement, with 100 % agreement.

Experimental Design

The study implemented an ABAB reversal design. Prior to beginning intervention, a parent interview was conducted to gather information about the participants sleeping patterns, preferred stimuli, and known reinforcers. The parent indicated that prior to intervention, his mother would place the participant on his side and leave the room. Within 1 to 2 minute, he would roll to his back. The parent would then re-position the infant on his side several times.

Baseline Condition

During baseline conditions, the organization of stimuli in the room included a mobile hanging over the crib and a rotating light that projected shapes onto the ceiling. Based on parent report, the participant seemed to enjoy the mobile and projected lights. The parent was instructed to place the infant on the crib in a side-lying position and leave the room. She would then return to the room every 5 min to check on the participant. If, during these check, he rolled to a supine position, she would roll him back to a lateral position. No other attention was provided during baseline.

Treatment Conditions

During treatment phases, antecedent manipulations were utilized which included relocation of particular stimuli and non-contingent attention. First, positioning of the preferred stimuli was changed so that the mobile was hanging to the side of the crib. The light was turned on its side so the shapes were projected onto the wall next to the crib, rather than the ceiling. Secondly, parent-mediated, non-contingent attention to encourage lateral positioning was implemented. When the participant was placed on his side, the mother was instructed to be seated beside the crib on the side the participant was facing. She was instructed to interact for 5-minute intervals with the child which included singing, making physical contact through the crib, making positive statements regarding behavior, and making comments about the preferred stimuli. For example, she would spend 5 minute beside the crib, then leave the room for 5 minute, and then return for 5 minute. This intermittent schedule was implemented as recommended by the medical provider to allow the infant an opportunity to fall asleep as continuous parent presence would likely prevent the infant from falling asleep. If the participant rolled onto his back, his mother was instructed to return him to his side, as consistent with the baseline condition. As well, if the participant fell asleep during the observation session, the parent was instructed to discontinue the non-contingent reinforcement procedure. Of particular note, the side the participant was placed on as well as stimuli placement was rotated each intervention session. This practice was implemented to prevent risk of positional plagiocephaly, which increased since the recommendation of supine sleeping due to repeated postures on one side or position (Pogliani, Mameli, Fabiano, & Zuccotti, 2011). It should be noted that this procedure was discussed with the participants' medical provider to ensure safety and medical compliance.

Results and Discussion

The results of the intervention are depicted in Fig. 1. In three out of four baseline sessions, the infant did not maintain a lateral position for the full duration of any interval. Following implementation of the treatment package, the participant significantly increased the number of intervals where he demonstrated a sustained lateral position, averaging 67 % of intervals. Upon withdrawal of the treatment, lateral sleeping returned to levels slightly above baseline, averaging 10.5 % of intervals. In the final treatment phase, the participant demonstrated an average of 88.6 % of intervals where he maintained a lateral position. Results from this study provide increased evidence on the efficacy of behavior analytic intervention for infants and very young children. This work could be generalized to a

Fig. 1 Results of the intervention. The graph demonstrates significant effect in the treatment phase, with satisfied intervals returning to near baseline levels upon reversal, further strengthening the demonstration of experimental control

variety of challenges with this population and should be a continued trajectory of clinical research.

Although the results of the intervention were favorable, there were numerous limitations. First, we realized that the terminal or initial goal was to increase lateral sleeping which was essentially not addressed within this study. We hypothesize, if the participant can maintain a lateral position in his crib, the location has been previously paired with napping and therefore will increase the likelihood he will fall asleep in this position in the future. However, this will need to be specifically investigated further. Data collection which includes latency until the participant rolls to his back can also be useful in further understanding efficacy of the intervention. Still, the participant fell asleep in nine of the 12 intervention sessions and remained asleep and laterally positioned for the remainder of the session. Future research should focus on replicating this study, with the added component of latency until sleep in the treatment phase as opposed to baseline conditions. Also, studies that integrate polysomnography and more sophisticated means of sleep monitoring when combined with such behavioral intervention to determine physiological benefit would be a valued addition to the existing literature. In addition, future research should evaluate a series of infants with OSA and examine effects of this treatment as compared to a control group.

Unlike similar studies, this study did not record maladaptive behaviors resulting from requiring the infant to maintain a particular posture. While such behaviors did present during this study, they were not recorded as with previously conducted similar studies. The parent-mediated social reinforcement required to keep the infant on his side may in fact reduce instances of sleep in the future, which should also be further evaluated. Finally, this study is consistent with a multi-element treatment package of two antecedent modifications, as well as parent-mediated continuous social reinforcement. A component analysis may be necessary to determine if each of these interventions were required to attain the same effect and to what degree each were effective independent of one another.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Informed Consent Informed consent was obtained from the parents of all individual participants included in the study.

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